DOCUMENT RESUME

ED 287 813 SP 029 342

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TITLE Preparing Urban Teachers for the Technological Future.
SPONS AGENCY Ford Foundation, New York, N.Y.
PUB DATE Jul 87
NOTE 29p.; Paper presented at the World Assembly of the International Council on Education for Teaching (34th, Eindhoven, Netherlands, July 20-24, 1987).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Educational Needs; Elementary Secondary Education; *Futures (of Society); Teacher Education Programs; Technical Education; *Technological Advancement; *Urban Education

ABSTRACT

This report reviews the results of a survey of teacher training programs in technology among 28 urban school systems in order to ascertain the current state of school computer use and teacher retraining. Results indicate that preparing students for the future presents particular problems for urban schools. With technology restructuring jobs and creating new types of work, the only clear prospect is that students will have to learn generalizable skills that allow them to adapt to the changing workplace. In urban settings, limited resources, large populations, and special non-educational needs create educational experiences for students that are different from those of their suburban counterparts. Inequities of resources threaten to repeat themselves in the area of technology education. Teachers need preparation for being learners in this changing field. Technology affects the curriculum, classroom arrangements, measurement of student performance, and the teaching role. "Top-down" approaches to training seem to prevail, with teachers providing little input in deciding what type of training they need. Several recommendations are made for improvement of teacher training in this area, addressing the specific needs of urban schools. (CB)

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PREPARING URBAN TEACHERS FOR THE TECHNOLOGICAL FUTURE

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This paper was prepared with the support of the Ford Foundation. The content is solely the responsibility of the authors. We wish to express our appreciation to the many district administrators who generously took the time to talk with us, to the Bank Street College Computer Outreach staff, and especially Stephen Shuller, and to the teachers and researchers who contributed their observations to this effort. Nina Gunzenhauser provided invaluable editorial help.

SP029342

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Preparing Urban Teachers for the Technological Future

Abstract

This report reviews the results of a survey of teacher training programs in technology among 28 urban school systems. How teachers are trained will be a critical factor for urban schools in achieving their educational goals and in shaping the uses of electronic media. Issues confronting urban educators are discussed, including demands for training, trends to tool use of computers, equity of access, and resources are discussed. Characteristics of programs, which teachers often have no say in determining, are described and recommendations are made for supporting and implementing appropriate teacher training in anticipation of schools' future technological needs.

PREPARING URBAN TEACHERS FOR THE TECHNOLOGICAL FUTURE

Karen Sheingold, Laura M. W. Martin,
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Education in the Age of Technology

In 1980, a team of researchers from Bank Street College spent several months studying the implementation of microcomputers in three very different school systems. The purpose of the study was to identify issues that cut across the specifics of implementation in each district (45). The issues identified then included: differential access to microcomputers; emergence of new teacher and student roles (teacher buffs and student experts) in response to microcomputers; the lack of integration of microcomputers into elementary classrooms and curricula; the inadequate quantity and quality of software; the inadequate preparation of teachers for using microcomputers; and the lack of incisive research on the effects and outcomes of the instructional use of microcomputers.

In 1986 all of these issues remain relevant. In most cases, they are more critical now than they were five years ago, since the number of microcomputers in schools has increased independently of solutions to the problems of quality software, effective teacher training, or research. While each of these issues deserves its separate analysis, the focus of the current report is on teachers, in particular, teachers in urban schools.

Urban school systems must meet the educational requirements of large, heterogeneous, relatively poor populations at a time when employment and resource patterns are undergoing major shifts. Although job opportunities in the cities are currently decreasing, analysts expect a labor shortage in the next decade (4). Despite a tapering in population growth (50), the big city districts still have the largest pupil enrollments in the nation (32). These districts recognize that if their students are to be part of the future work force, they must share in the educational advantages afforded by the new technologies.

Addressing the unique features of urban schools and of urban school populations is critical in planning for the widespread use of electronic innovations. Unfortunately, however, the needs of cities have not

been adequately targeted by hardware and software designers and manufacturers, by policy makers, or by researchers. In describing how school systems are helping teachers to prepare for the future, our report seeks to contribute to explorations about how technology may help the students.

To inform the report, we gathered information by reviewing research, conducting phone interviews with teachers and computer personnel in many large school districts, and having in-depth discussions with experienced teachers and teacher trainers in the New York area. Since we could not visit school districts to observe and evaluate teacher training, our findings to date are provocative and suggestive, not definitive.

We begin with the assumption that how teachers are educated with respect to the new educational technologies will prove to be critical in shaping education in the next ten years. Teachers are faced with a work situation that is changing rapidly. They must become acquainted with the possible directions the technology can take and be prepared to design and experiment with options that make sense for them and their students. We argue that programs of staff development are needed that do nothing less than make teachers important builders of the school of the future. All of this is particularly important in urban schools, where a long history of inequality of educational opportunity for poor and minority students threatens to repeat itself in the domain of technology.

In what follows, we examine how training and technology issues are handled in current programs. We discuss how they might be handled to prepare teachers for the future, especially in the urban setting. Our discussion necessarily leads us to explore the workplace and visions of technology uses and users both at work and at school. Finally, we draw conclusions and make recommendations.

Preparing Students for the Future

The introduction of microcomputers into this nation's public schools has proceeded at a pace exceeding predictions. Between 1981 and January 1984, the number of school districts with microcomputers almost doubled, and the percentage of districts with microcomputers rose from 38.2 to 75 (42). Even more dramatically, the number of schools with microcomputers more than tripled in that period, from around 14,000 to more than 55,000. In the fall of 1983, Quality Education Data counted almost 300,000 microcomputers in the nation's schools. It is generally accepted that there are now at least one million.

Were hardware acquisition our only measure, we could safely conclude that some important innovation was under way. What makes this conclusion uncertain is that the rate of change in education is usually slow, while that in computer technology is very fast. School administrators know that the computers they purchase today will soon be superseded by newer models. Teachers know that the software they are learning to use will soon be replaced by something else. While some teachers are very enthusiastic about the new technology and its potential for student learning, others assume that computers will go the way of many previous educational innovations--into the closet.

The closet scenario is very unlikely, however, given the large investment already made in microcomputer technology nationwide, the rapidly decreasing cost of the technology, and the powerful forces outside of school--parents and the workplace--that are placing microcomputers in a prominent educational position.

As for parents, it is hard to think of any previous educational innovation that has so captured their determination and energies. In many communities, parents have taken the lead in bringing microcomputers into the schools, through pressure on school and district administrators and through their own fundraising efforts. Many parents believe that computers hold an important key to their children's future, that if their children do not have opportunities to use computers in school, many doors to the job market will be closed to them. Some of the same thinking lies behind the commitment of many schools to programs of "computer literacy" (11, 31). Since computers are becoming an ever-present technology in today's society and the workplace, so the argument goes, students should know what they do as well as how to use and program them.

Technology and the Workplace

But just what is the connection between knowing about computers and getting jobs? And what are the likely effects of technology on the workplace? The Bureau of Labor Statistics projections (44, 25) prompt some analysts, such as Levin and Rumberger (23), to conclude that technology will deskill workers, resulting in large numbers of low-level jobs (food service workers, janitors) and relatively small numbers of "high tech" jobs. Others (34) argue that although jobs may be downgraded in status (salary, benefits, and chances for promotion), technology will result in a simultaneous upskilling; that is, many jobs not in high technology industries per se will require greater conceptual skills.

Several things are clear, regardless of which viewpoint one takes in the workforce debate. High technology jobs are not likely to be a

significant portion of the workforce ten years from now. These jobs represented 6% of the workforce in 1982, the same percentage as in 1972 (44). While many workers will be using computers in the 1990s, few will be high technology scientists and engineers; rather, they will use computers as powerful tools to accomplish work-relevant tasks. Technology in the future is likely to restructure jobs within particular settings in ways that are sometimes radical and not easily predicted from current economic models (5).

Work in the nation's cities is changing significantly and the job market is narrowing. Heavy industry that in the past employed urban school graduates in the mid-Atlantic region is becoming roboticized. Even when a decline in the heavy industry jobs that previously went to city youth is balanced by expansion of light industry jobs in the surrounding suburbs, the city's high school graduates may not be moving to those jobs. In the last ten years, for example, New York City has lost thousands of jobs that previously went to youth (36). At the same time, white-collar employers such as insurance companies and banks have computerized many entry-level clerical tasks and, more importantly, eliminated a level of "back-office" jobs that used to link entry-level jobs to middle-management and executive jobs (34, 35, 37). Many service jobs--in hospitals, schools, and municipal systems--are being streamlined by technology (23).

With technology restructuring some jobs, eliminating others, and creating new types of work altogether, no one can look forward to doing the same type of job for life or to a traditional "ladder" toward upgraded job categories (36). In this age of technology, neither employers nor educational reformers (17, 47) are calling for students to learn technical skills.

For today's workplace, employers want high school graduates to have:

> the ability to read, write, reason, and compute; an understanding of American social and economic life; a knowledge of the basic principles of the physical and biological sciences; experience with cooperation and conflict resolution in groups; and possession of attitudes and personal habits that make for a dependable, reasonable, adaptable, and informed worker and citizen (30).

Employers rely on the schools to teach these general intellectual and social skills and are willing to take on the responsibility of detailed technical training themselves (30, 35).

These changing prospects emphasize the necessity for students to learn "movable" skills that enable them to adapt easily to new situa-

tions. Generalizable skills of literacy, problem solving, decision making, and communicating take on greater importance in preparing students to work. In earlier times, many business transactions were divided into separate clerical tasks, and a complete paperwork process was not carried out at one location. With computers, complete transactions can be carried out by one person. But that individual must understand the goals of the transaction, its component parts, and the relations among these components (34).

Partly because of the ways in which technology is transforming the workplace, general intellectual skills and comprehensive literacy are now necessary goals for mass education (43). To the extent that computers can be enlisted in the service of these critically important educational goals, their impact on education will be significant. For those students who wish to have computer science or engineering as an option for their future, being able to study the computer per se (programming, computer science) may be appropriate. But using the computer as a tool to achieve goals of learning, thinking, and literacy is likely to be of greater relevance to the needs of most students.

Issues for Urban Schools

Preparing students for the future presents particular problems for the schools in large urban settings. While the general goals of education in the inner city are no different from those elsewhere, factors such as limited resources, the large sizes of districts, and the special needs of relatively poorer student populations have contributed often to very different educational experiences for inner-city children and their suburban counterparts. Lower test scores, higher dropout rates, and poorer employment prospects are a few of the indicators of the widespread inequities faced by city youth.

Familiarity with the computer, now considered part of a "good education" (21), has been seen both as a means to remedy educational inequities and as a potential source of greater inequities. Concerns among parents and educators about equity of access to computers mean that urban systems are spending a lot of money to make sure schools, particularly high schools, are technologically equipped. While large school districts have led the way in acquiring microcomputers for instructional purposes, in the 1983-84 school year urban schools were somewhat less likely than wealthy suburban schools to use microcomputers (69.1% to 72.6%) (42). In addition, districts with approximately 50% minority students were less likely to have microcomputers than were districts with minority enrollment of less than 25% (68.4% compared to 81.0%) (42).

Equal opportunity to have contact with computers is only part of the issue. The funding by which urban systems often acquire hardware may limit machine uses (46). Such restrictions may work against the best educational interests of students in at least two ways. First, where uses are limited to remedial tasks or to drill, emphasis in mastery of basic skills becomes the central academic goal for students. In contrast, students in suburban schools are more often using computers in the service of more comprehensive literacy and reasoning goals (11). Thus, the use of computers can perpetuate a system in which more privileged students are expected and helped to achieve more generalizable literacy skills than are their less privileged counterparts. Secondly, the machines may be limited to business courses (i.e., word processing, spreadsheets) and programming courses. This makes it likely that girls and boys will have different access to the technology (18).

A prevalent source of student alienation from school occurs in the mismatch between patterns of learning in the school and home. Some educators foresee that the computer, being a new and relatively undefined entity for everyone, may offer an opportunity for students, teachers, and parents jointly to decide and describe common educational approaches. In order to avoid computers' becoming yet another arena of mismatch, several large school systems have developed strong parent involvement components, allowing parents to borrow machines and thus work on computer-related school tasks with their children (12).

Teaching in an Age of Technology

While there has been a great deal of discussion about the potential of new technologies for the education of students, less has been said about the ways in which technology may affect teachers and the profession of teaching. What is true for students is also true for teachers: they need preparation for being learners in a dramatically changing field, and they need additional training necessitated by transformations at their workplace. At this point, exactly what forms the retraining takes must rest on a range of untested assumptions, just as curricular innovations do. We can, however, attempt to anticipate the changes to come from what we know about computers, their entry into schools, and the rapidity with which they are changing (39).

Futuristic thinking is always risky; whatever we predict will almost certainly be wrong to some degree. But for education and technology, it is more risky <u>not</u> to think about the future. Many believe that the power of this particular innovation is likely to transform

education radically (14, 41). While some possibilities are exciting, others are profoundly problematic. Here, it will be useful to distinguish between projections which are based on what is already in place from more visionary speculations about the teacher and school of the future (asterisked sections).

Developers are already at work on information-management systems for students, complex performance analyzers, authoring systems with which teachers can customize programs, and telecommunicative linking of classrooms. Widespread use of such tools would affect the content, structure, and organization of schools, and thus the role played by the teacher.

Curriculum and Teaching

The content of school curricula, for example in mathematics, is already changing and is likely to change further as a result of an assessment of what students ought to know and need not know in a computer age (33). More generally, the greater emphasis on thinking and learning skills that educators are calling for (43, 1) may be heightened by the move to include computers in schools. If access to vast amounts of information is made possible through the technology (i.e., large databases accessible via telecommunications), then learning of facts may become relatively less important than learning how to search, query, make sense of, and evaluate information. While these skills are currently being taught, they are neither given high priority nor are they commonly well defined as curricular goals. Researchers are only beginning to study the organization of inquiry, research, problem solving, and decision making in classrooms (19).

* As curriculum changes, the role of teachers may shift from that of providers of content-specific information to facilitators of students' own information-organization skills (46). Instructional techniques might shift away from direct delivery of information toward greater emphasis on shaping students' mastery of information and their thinking skills--finding relevant information, solving problems, asking questions, thinking critically, and communicating ideas. The teacher of the future would need to know how to teach procedural and "metacognitive" skills.

Classroom Management

In the near future, a teacher may be managing something very different from a classroom full of students who are doing individual paper-and-pencil seat work, listening to a lecture, or engaging in large-group discussions (11). Computer simulations and many computer tool uses, for example, make possible and support students' joint problem

solving (27). A teacher guiding students working together on computers in pairs or in groups requires observational and management skills different from the ones she normally applies, as well as new understandings about when and how to intervene in the student-based activity.

Effective use of computers as information-delivery systems in school settings may enable students to move through some academic content at an individual pace. Students may work alone much more than they do now, as some college students do in "self-paced" classes, or grouped with a few others in particular academic domains.

With the introduction of computer-based networks, "classrooms" could include students and teachers who are working together across long distances.

* To the extent that instruction becomes individualized, the usefulness of age-graded classrooms may be called into question (2). It may be, too, that the location of learning can be wherever the technology is, namely, the home, library, or community center. Thus, the purposes and functions of school buildings may change (24).

Measurement of Student Performance

In some schools, the computer manages simple instruction; that is, the computer keeps track of students' performances on drills. In two large urban areas we contacted, the basic mathematics and language arts curricula exist as exercises in a computer accompanied by a set of diagnostic tests. Teachers test the children every two to three weeks to pinpoint weaknesses. Hopefully, this kind of assistance frees the teacher for more challenging work.

Computer-based activity of the more open-ended variety can provide teachers with new insights into what their students can do. Anecdotal accounts describe how teachers have learned new things about their students' capabilities as a result of observing them interacting with peers at the computer (7, 40).

With a greater emphasis on skills of abstraction and comprehension, what student achievement consists of and how it is measured will need to change (16). For example, the advent of the pocket calculator has meant that mathematical operations and estimation can be emphasized over calculation. Word processors have resulted in a new emphasis on the writing process, as opposed to spelling and penmanship.

Standardized tests are already being altered to reflect new pedagogical goals (10, 15).

Determining whether a student is a good problem solver who can envision multiple solutions, plan solution strategies, and estimate outcomes is very different from counting how many problems a student answers correctly. A composition may no longer be judged simply by the number of spelling and grammatical errors it contains.

* Through future "intelligent" computer systems, it may be possible to promote and diagnose student performance in new ways (48). Based on the student's performance, these systems might prompt the student to reconsider an answer, demonstrate a different process for solving a particular problem, or ask the student to indicate why she thought a particular response was correct.

  Other types of intelligent systems might help teachers understand how students learn and solve problems by analyzing students' errors (8). Such diagnostic functions, if developed with the needs of teachers in mind, could help teachers zero in precisely and effectively on students' conceptual difficulties. In order to use such systems, however, the teachers would need to learn new ways of dealing with detailed information about aspects of students' cognitive performance.

The Role of Teachers in Shaping the Future

Three characterizations of the teacher in relation to the technology process may be distinguished. Each one has clear implications for training. As bystander, the teacher's role is considered as irrelevant to or unchanged by the introduction of "teacher-proof" technology into classrooms. This naive view implies providing teachers with a minimal computer literacy and classroom management training. Consumer roles attribute a gatekeeper function to the teacher, who is trained to decide which products to use from the array in the educational market. Finally, the characterization of the teacher as a builder derives from early classroom computer innovations in which individual teachers not only select but redefine learning activities using technology. In turn, significant ideas for revising the technology are generated from such on-site experimentation. This view implies a long-term professional development process of training rather than brief contacts with the new educational materials. If the teacher's role changes in ways suggested here, the teacher will have to build new ways of making learning happen in the classroom.

The work of teaching is likely to change with respect to curriculum content, classroom management, and student assessment as a result of

the new educational technologies. Approaches to training that view the teacher solely as a bystander to or as a consumer of hardware, software, and curricula that others design may be completely inadequate to prepare teachers for the future. Perhaps more importantly, such approaches are unlikely to provide teachers a significant professional role in shaping that future. Technological transformations will be adopted by teachers to the extent that the technology is meaningful and integral to their teaching situations. This means that teachers must be encouraged as partners in the creative enterprise.

The Study, Its Findings and Implications

To ascertain the current state of school computer use and teacher retraining, a sample consisting of 28 nationally distributed districts was selected (see below). They represented cities ranging from 300,000 to over 7 million people, plus four large districts in either suburban or mixed urban/suburban/rural areas. Their school populations ranged from 45,000 to over 1 million. Minority students constituted 9% to 75% of the total school population in the districts (mean = 43.3%).

Districts Surveyed

Albuquerque, NM	Los Angeles, CA
Baltimore, MD	Manhattan, NY
Boston, MA	Memphis, TN
Chicago, IL	Milwaukee, WI
Cleveland, OH	New Orleans, LA
Dade County, FL	New York City, NY
Denver, CO	Oakland, CA
Detroit, MI	Philadelphia, PA
Fairfax County, VA	Pittsburgh, PA
Granite County, UT	San Diego, CA (TECC #15)
Houston, TX	San Francisco (TECC #5)
Indianapolis. IN	St.Louis, MO
Jefferson County, CO	Tucson, AZ
Washington, DC	

Information about the computer programs of the selected sites was gathered in several ways. At 23 of the sites, a district person responsible for computer education was interviewed by phone. Five communities provided written materials. Finally, 18 people were interviewed who were employed by communities or involved in training or documentation of school computer programs. These interviews sought to elicit a description of implementation, the concerns of teachers, perceived obstacles, and ideas for interventions and activities that would support school systems in the development of educational computing.

Five general findings of our research have particularly significant implications for staff development. These include the fact of high demands for training, the development of "top-down" approaches to planning, a trend toward using computers as tools, the presence of complex equity issues, and the scarcity of resources for computers and for training in urban districts.

Demands for Training

The demands for training teachers in computer use are very high, from both the districts and from the teachers themselves. At least 50% of the districts surveyed wanted their secondary school teachers to integrate computer use into the existing curricula of their disciplines, and 75% mentioned the goals of computer "literacy" and "awareness" for all their teachers. Few teachers, however, are emerging from departments and schools of education with appropriate preservice training (6, 49). Fewer still have a level of computer skill that matches the needs of schools. Since there is a shortage of well-credentialed new teachers, the need for preparing teachers who are currently employed is great.

Several states have instituted requirements in computer competency for teacher certification, and others are in the process of doing so, but in general participation in training is voluntary. In most cases, voluntarism is a necessity: contracts do not permit mandatory training; districts are not equipped to handle large-scale training and are reluctant to pay for alternative classroom coverage for mandated released-time training. In inner-city schools, where educational continuity is already a problem because of a mobile student population and high absentee rates, teacher absence is seen as particularly undesirable. Compulsory training is therefore usually restricted to those who teach computer science and those responsible for implementing computer curriculum goals at certain grade levels. Districts do encourage participation in training programs by offering recertification credit, graduate credit, or monetary rewards.

Even under a voluntary system, districts are finding no lack of participants for the programs they offer. While some teachers are skeptical about the value of technology, many wish to learn computer skills, and some districts report that they can't keep up with the demand. Several districts claim to have already trained thousands of teachers. Some districts are having such difficulty keeping up with the demand for computer training that they are requiring formal application, principal recommendations and, in some cases, fees.

Voluntarism has specific advantages in the implementation of computer goals. It allows teachers to become engaged with computers at their own pace, to select their own entry point, and to choose among a variety of courses on the basis of personal interest. In this way, they are more likely to formulate meaningful goals and to achieve them (38).

The negative side of this approach is that there may be a poor match between the training available and the classroom situation teachers

must face. Teachers sometimes receive training that they cannot put to use in their classrooms, and the result is frustration. Even when teachers can use what they have learned, their training is often inadequate to make them competent users of computers. In addition, there appears to be little articulation of needs special to urban educators on the part of those responsible for teacher training.

Given the innovative potential of computers, the patterns of change in their use, and the uncertainty about how best to train students and teachers, it seems important to foster district commitment to "staff development"--long-term professional growth in the field--rather than to "inservice training"--immediate, quick immersion (26). To use the technology effectively, teachers need the chance to learn and experiment over a long period of time with support from other teachers, administrators, and experts. Such a long-term approach, with continuing support for training, is most likely to ensure that the training will be assimilated and that the technology will be put to its best use (29).

"Top-Down" Approach

Many school systems are adopting a "top-down" approach to planning, in which the teacher is the consumer of a plan developed and implemented by specialists and administrators at the central office level. Large city school systems, which must deal with up to a million students and thousands of teachers, tend to see central planning as the only sensible choice. They are also highly responsive to local pressure and to demands for accountability, and it is easier to be accountable when programs are designed and controlled at the central office level.

Twelve of the districts surveyed have already committed themselves to firmly developed and, in several instances, highly specified computer education plans. Of these, eight are to be implemented over three- to five-year periods. In some cases, specific computer applications are being written into curriculum guides.

The top-down approach is a disturbing trend. The large-scale, uniform, and prescriptive quality of such an approach may rigidify the use of technology in schools long before the educational potential of the technology has been developed and researched. Training programs that are driven by the need to institute change all at once, on a large scale, may well be less adaptive in the long run than training arising from classroom needs and individual teachers' visions of what they want to do with computers (3).

When such planned programs of districtwide computer use and teacher training are developed in the district office, teachers are essentially

left out of the process, although teacher representatives may sit on district advisory boards. Yet the experienced and thoughtful teacher, given a brief acquaintance with the possibilities of computers, can contribute greatly to decisions about how--or whether--to use them. As we have seen, some of the most imaginative and successful uses of the computer in schools today have come from teachers who were willing to redesign learning activities to take advantage of the technology or who discovered new dimensions in the technology that could be shaped and revised for use in education.

Teachers should be central participants in and builders of the future of technology in education, not solely the recipients of decisions made by others, either in the areas of training or in tool design. Specifically, they should be supported and encouraged to adapt computers to their own and their students' purposes, to explore the ways in which technologies can alter what happens in the classroom, and to share what they do and what "works" with other teachers. Their influence should be felt on what gets created and marketed for schools during the process of development, not after. Teacher development programs must support teachers to shape and engage in "experiments" with technology, experiments that can inform and influence the future of technology in education. For districts with large numbers of poor and minority students, such an approach will make possible local design and implementation of programs that may be of particular benefit to such students, and to their teachers.

Trends to Tool Uses of Computers

The focus of educational uses of computers has shifted from computers as objects of study (programming and computer literacy) to computers as tools for learning. While programming is still a popular activity at the secondary level, its importance is increasingly questioned in the lower grades, and only 20% of the districts surveyed defined their educational computing programs as a computer literacy curriculum for K-12 students. The current school goal is the integration of computers throughout the curriculum.

The most frequently cited activity is word processing, which is no longer confined to courses intended to prepare students for careers in business. The computer is slated to become a writing tool of the English Department and of remedial education and, in places where there is adequate equipment, of the social studies, the sciences, and other disciplines.

Another frequently reported computer activity is database management. The use of popular commercial systems is still taught in computer science and business courses, but electronic filing systems are

also turning up in social studies and science, home economics, and health education. Some school systems are creating local databases that students can access through a local area network (LAN). Others allow students to go "on line" through telecommunication systems to access large, nationally available databases.

The use of electronic spreadsheets is another computer skill that is beginning to be more widely taught. Business-course students in high schools are the primary target for this training, but spreadsheet packages are also turning up in high school math and science classes, and anywhere else that students need to manipulate interdependent, quantitative variables and teachers understand the applicability of the spreadsheet as a problem-solving tool.

Concurrent with repeated shifts in computer use, teacher training is reported to have entered a new phase. This new phase places priority on applications of the computer. In the long run, such emphasis may promote smaller scale, more personalized training programs, since applications lend themselves to multiple uses.

We remain skeptical of the quality of the current state of training and implementation of tool uses in schools. Using software that was not designed for the classroom environment creates instructional difficulties (20). In a series of classroom-based studies on the use of database management software in Northeast school districts, it was noted that "few schools are currently using them, even fewer are using them with students in classrooms, and only a handful of teachers are making substantial or creative use of the software" as thinking tools (19). Rather, in the schools visited, the software was often used to illustrate business uses of software. It was not integrated into the "business" of classroom learning.

Despite these difficulties, the refocusing of the goals of school districts on tool uses and on the integration of computers with curriculum are encouraging developments. Accomplishing these goals, however, makes much more serious the role of long-term staff development. Using computers effectively as tools in the classroom requires rethinking how some kinds of work get done in the classroom--both the content and the social context of that work (45).

Equity in Access to Computer Education

The largest school districts have been leaders in the rapid increase in the use of microcomputers for instructional purposes. This year, students in large high schools of the nation's largest school systems are virtually certain to have access to an educational computing program. Junior high school students in large schools in these

systems are the next most likely to have organized access to computers. Elementary school students are still the least likely to use computers in their school programs (42). School systems that have multi-year plans for computer purchase and program development tend to start at the high school level and work down year by year, reasoning that the younger pupils will eventually have their opportunity for computer exposure.

A widespread concern for achieving computer access equity for inner-city students has meant that in spite of limited resources in general, schools are spending a lot of money in this area. But while urban high school students are now probably just as likely to be in contact with computers as are suburban students, students at elementary levels are not (42). Favoring secondary over elementary students may accentuate inequities. The kinds of skills that educational analysts hope computers will promote are acquired early in the educational career--that is, before high school (17). By the ninth grade, a selection process is in place, eliminating choices of careers and courses for some students, especially for minority ethnic groups and for girls in general.

Moreover, inequities may exist in how computers are used. More advantaged students are more likely to use computers in ways that promote new learning, while less advantaged students are more likely to use them for drill (15, 27). To the extent that computer use is increasingly being infused into the curriculum, it may address the problem of equity of access. For example, where word processing is taught only as part of business education, it becomes the domain of female students. Where database management is part of a computer science elective, boys are overwhelmingly the recipients of the training (9). But when these skills are introduced as part of English, social studies, or some other part of the curriculum compulsory for all students, the situation changes. Many students--boys and girls, minority and majority, at all achievement levels--are at the keyboard learning computing skills along with their subject area studies.

Urban schools face special problems in integrating computers with the curriculum. Lack of equipment, security concerns, class size, and teacher training availability are some. For some communities too, there is a critical lack of bilingual software as well as a lack of support for developing these educational tools (13, 28).

For a teacher trying to meet the many educational and social needs of urban students, computer training that is perceived as useful is vital lest the technology be rejected as one more burden. With fewer resources for staff development in the inner cities than in more affluent districts, there is good reason for concern that skepticism on

the part of teachers about the utility of computers will inadvertently be reinforced and that the hardware now in place will not be utilized to its fullest capacity.

Scarcity of Resources

Predictably, many communities cite insufficient funds as a major obstacle to implementing computer programs in the schools. The school districts sampled are some of the largest in the country, and they are beset by general budget problems: loss of population, a weakened tax base, loss of federal funds, and budget-capping by the state. They must try to respond to social and financial inequities that exist among different areas of the community, as well as between inner-city populations and those of the suburbs.

The cost of providing computers is tremendous. State and federal funds have been inadequate to meet even minimal needs. In many districts, Chapter I funds have been used to equip compensatory education programs, but access to such programs is limited to those students eligible by reason of school failure and low socioeconomic status. Chapter II funds (federal funds administered as block grants through the states) are more flexible and have been used by several districts. The level of state funding specifically targeted for computer programs varies greatly.

Community resources also vary widely. In a district with a concentration of business and industry, local businessmen may cooperate in "adopt-a-school" programs, providing such support as equipment donations, technical consulting, and summer employment for students. Some districts have large research universities supporting experimental programs; some have active parent groups that take the lead in organizing, equipping, and consulting for the school's computer program. In many districts, however, limited funding has resulted in difficult decisions about allocating equipment, especially when the district includes both low-income areas and more affluent schools where some equipment is already in place.

Federal and state funding for training is less available than money for the purchase of hardware. In fact, it is rarely available. Moreover, in many places expertise for training is in short supply. While in some districts universities and schools of education have been able to provide training resources, for the most part Higher Education lags far behind the school systems themselves in understanding and responding to the need for training.

Finally, resources for well-researched quality software have not been forthcoming, either from government or from commercial sources (31).

There are great limitations in the programs geared for school use, as well as in the research-based knowledge about how to create programs most useful for students' learning and teachers' effectiveness. Here again, we see the need for teachers' perspectives and expertise to inform research and development efforts (22).

Conclusions and Recommendations

Our analysis of the retraining needs of teachers in urban schools for using computer technology has resulted in a complex story, with both encouraging and sobering themes. On the positive side, large urban systems are committed, as are their suburban counterparts, to making computer education available to their students and training accessible to their teachers. Moreover, there is a widespread and intense demand for training on the part of teachers. Since such training is almost always undertaken voluntarily, the demand indicates high interest and enthusiasm.

In addition, there is a marked shift in priorities for how students and teachers use computers toward tool uses of the computer and integration of the computer with the curriculum, in contrast to earlier emphases on the computer as an object of study and as a device for drill and practice. These are encouraging trends, since tool uses appear more likely to support the kind of learning, problem-solving, and information-management skills required of citizens and workers in the information age.

On the negative side, resources are severely limited. Many systems are unable to meet the local demand for equipment and training, and do not foresee any improvement in the funding picture. It is also not clear in what ways issues related to schooling for urban poor and minority groups are being taken into account in the training of teachers and in plans for school use of computers. Issues of concern to minorities and the poor, such as cultural differences, differences in family demographics and in home support for school activities, lack of resources, and limited job prospects are often ignored by decision makers and leadership in the field of educational technology. Definition is needed as to what are the best ways to use the technology to meet the needs of these students and their teachers for valuable educational experiences. Finally, and perhaps most distressing, is the trend toward top-down, short-term teacher training and program implementation in many large districts. While this trend is understandable, it may well undermine what the districts seek to achieve--an improvement in the quality of education.

Although there are many recommendations we could make, we restrict them to those that bear directly on improving teacher training and on addressing specific needs of urban schools.

1. Identify, support the development of, study, and disseminate effective models of staff development. Such effective programs of staff development for computer education should include goals to

support urban school efforts to improve student preparedness for the future, provide teachers with flexibility for coping with future developments in educational technology, and involve teachers as shapers of how technology is used in the schools. They would best be designed to:

- ensure that at least some of what teachers learn will be directly put to use in classrooms;
- include extensive support and consultation systems for teachers, both during and after training, through special meetings, in-class consultation, opportunities to visit other sites and attend conferences, and use of electronic networking;
- encourage professionalism in teachers by drawing on their skills to shape educational uses of technology and by providing voluntary, tailored training options, access to state-of-the-art technology, feedback mechanisms by which they can reflect on their practices, and dissemination of information on technology and educational changes.

2. Identify and support the development of effective higher education programs to create new expertise and new leadership in the fields of practice, research, and development of educational technology for the urban setting. Higher education should be providing in-depth education to urban practitioner-leaders and trainers, to those who have or wish to have policy-making positions, and to those who wish to make research and/or development in the field of educational technology their careers. The development and implementation of such programs deserve encouragement and support.

3. Design, implement, and study small-scale experimental projects with particular relevance for urban schools. Large-scale, comprehensive programs are often prohibitively expensive, difficult to implement and learn from, and less responsive to teachers' needs. What is needed now are small-scale, clearly focused, experimental projects in technology adoption by schools for which there are adequate resources to do a good job of implementation. Building on local involvement and enthusiasm, they should include support for helping participants reflect on and learn from what they do as they do it, and for assessing the extent to which project goals were met. Such experiments should also provide for imaginative and powerful avenues of dissemination for the models. Examples of ideas that might form the core of such experiments include: (a) using technology to promote comprehensive literacy in urban schools; (b) using computer networking to support teacher communication within and among districts; (c) involving parents in school activities with their children

via computers; and (d) introducing urban schools and teachers to state-of-the-art software and hardware under development, whose design they could both learn from and influence.

There are no quick, short-term, or inexpensive solutions to the problems of helping teachers in urban schools to use technology and assuring that the technology is put to the best use for the students in these schools. And technology alone, even put to its best use, cannot be expected to remedy the many deep problems that beset urban schools. But at this moment in our history, if there is a lever for renewal of education in this country, it is the microcomputer. Teachers who can use the technology in the interests of their urban students can be a major force in helping their students to function effectively as citizens and workers in the technology age.

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